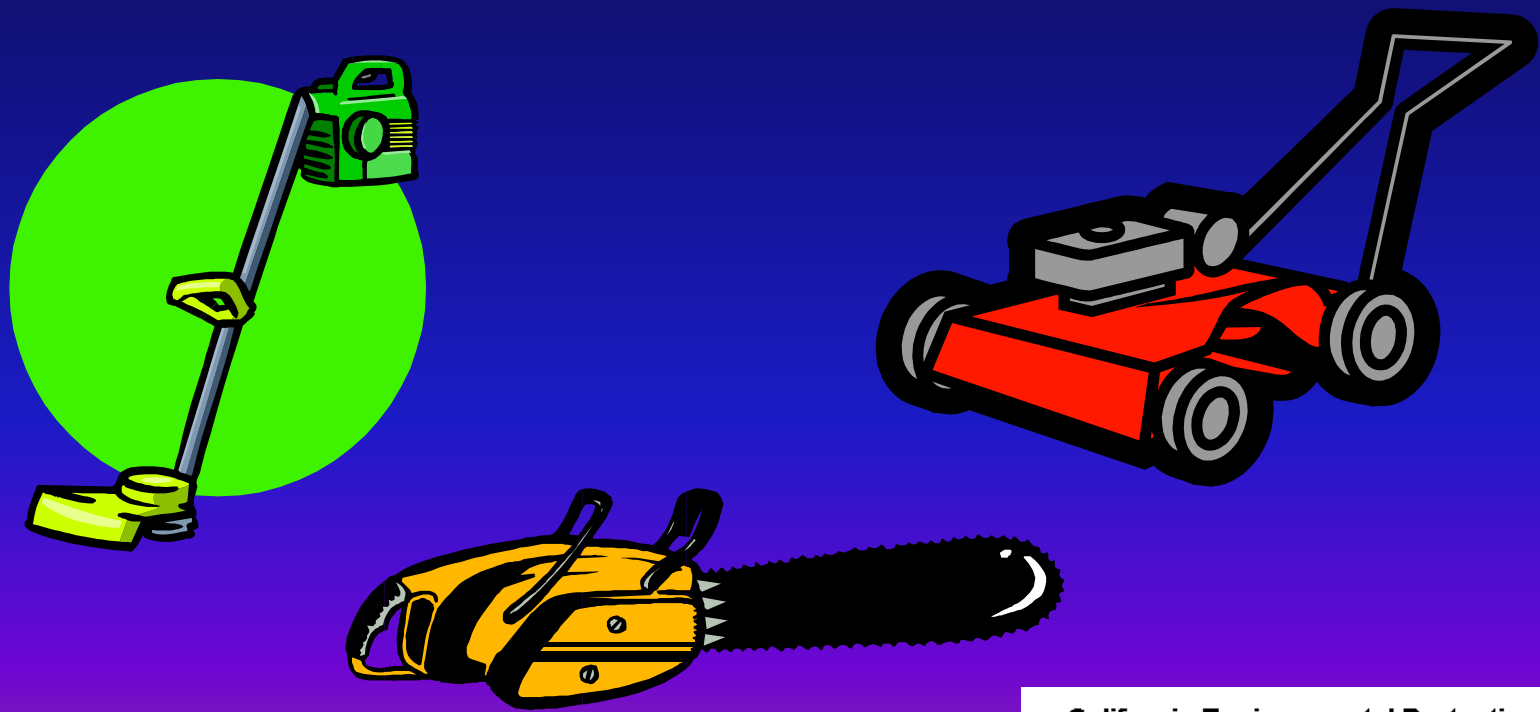
Evaporative Emission Certification Requirements for Small Off-Road Engines (SORE)

Monitoring and Laboratory Division (MLD)
Mobile Source Operations Division (MSOD)
California Air Resources Board

September 23, 2004



California Environmental Protection Agency
Air Resources Board

Outline

- Overview of New Evaporative Requirements
- Evaporative System Certification Overview
- Component Certification
- Design-Based Certification
- Performance-Based Certification
- Compliance
- Inventory Validation Study
- Exemptions

New SORE Evaporative Requirements (Applicability)

- Engines ≤ 19 kW
  - Engines grouped by displacement
    - ≤ 80 cc, handheld
    - > 80 cc to < 225 cc, small non-handheld
    - ≥ 225 cc, large non-handheld
- Two and four-stroke engines
- Lawn and garden and small industrial equipment

New SORE Evaporative Requirements
(Applicability)

- Regulations do not apply to:
  - Snowthrowers and ice augers
  - Engines or equipment that use compression-ignition engines
  - Farm and construction equipment

New SORE Evaporative Requirements (Handheld)

- Apply to small engines ≤ 80 cc
- Typical equipment includes string trimmers, leaf blowers, and chainsaws

Effective Date Model Year	Applicability	Requirement Tank Permeation
2007	Equipment That Use Gasoline Powered Small Off-Road Engines With Displacements ≤ 80 cc	Fuel Tank Permeation Emissions Shall Not Exceed 2.0 Grams Per Square Meter Per Day As Determined By TP-901.

New SORE Evaporative Requirements
(Small Non-Handheld)

- Apply to walk-behind mowers with engines > 80 cc to < 225 cc

	Performance Requirements Section 2754(a)	**Design Requirements Section 2754(b)**
Effective Date Model Year	Diurnal Standard Grams HC/day	Fuel Hose Permeation Grams ROG/m^2/day
2006	None	15
2007 and 2008	1.3	N/A
2009	1.0	N/A

New SORE Evaporative Requirements
(Small Non-Handheld)

- Apply to equipment other than walk-behind mowers with engines > 80 cc to < 225 cc

	Performance Requirements Section 2754(a)	**Design Requirements Section 2754(b)**		
Effective Date Model Year	Diurnal Standard Grams HC/day	Fuel Hose Permeation Grams ROG/m^2/day	Fuel Tank Permeation Grams ROG/m^2/day	Carbon Canister or Equivalent Butane Working Capacity Grams HC
2006	None	15	None	None
2007 through 2011	1.20 + 0.056*tank vol. (liters)	15	2.5	Specified in TP-902
2012	0.95 + 0.056*tank vol. (liters)	15	1.5	Specified in TP-902

New SORE Evaporative Requirements
(Large Non-Handheld)

- Apply to large equipment like lawn tractors and generators with engines ≥ 225 cc

	Performance Requirements Section 2754(a)	**Design Requirements Section 2754(b)**		
Effective Date Model Year	Diurnal Standard Grams HC/day	Fuel Hose Permeation Grams ROG/m^2/day	Fuel Tank Permeation Grams ROG/m^2/day	Carbon Canister or Equivalent Butane Working Capacity Grams HC
2006 and 2007	None	15	None	None
2008	1.20 + 0.056*tank vol. (liters)	15	2.5	Specified in TP-902
2013	1.20 + 0.056*tank vol. (liters)	15	1.5	Specified in TP-902

Evaporative System Certification Overview

- What are evaporative emissions?
  - Evaporative emissions are permeation and vented emissions from fuel storage systems

Evaporative System Certification Overview

- Evaporative emissions occur in four distinct phases:
  - Running loss - emissions occur during engine operation and include permeation and vented tank emissions
  - Hot soak - emissions occur for a one hour period after engine shutdown
  - Diurnal - emissions occur as a result of daily fluctuations in ambient temperature
  - Resting losses - emissions (mainly permeation) that occur at steady or declining temperatures

Evaporative System Certification Overview

- What are evaporative systems?
  - Evaporative systems are fuel system components designed to reduce emissions
  - Specially designed fuel hoses, fuel tanks, fuel caps, and carbon canisters are typically used to control evaporative emissions

Evaporative System Certification Overview

- What needs to be certified?
  - All small off-road engines or equipment that use small off-road engines sold in California must be certified annually
  - Preempt equipment not required to certify
- Who can certify?
  - engine manufacturers (B&S, Tecumseh, Kawasaki, etc.), or
  - equipment manufacturers (Simplicity, John Deere, Murray, etc.)

Evaporative System Certification Overview

- Engines or equipment must be certified under one of the following options:
  - Design-Based Option, 13 CCR 2754 (b)
    - Compliance demonstrated by using components that meet specified performance requirements
    - Likely option for equipment manufacturers that purchase engine without fuel tanks
  - Performance-Based Option , 13 CCR 2754 (a)
    - Compliance demonstrated through diurnal test
    - Likely option for engine manufacturers that sell engines with complete evaporative systems

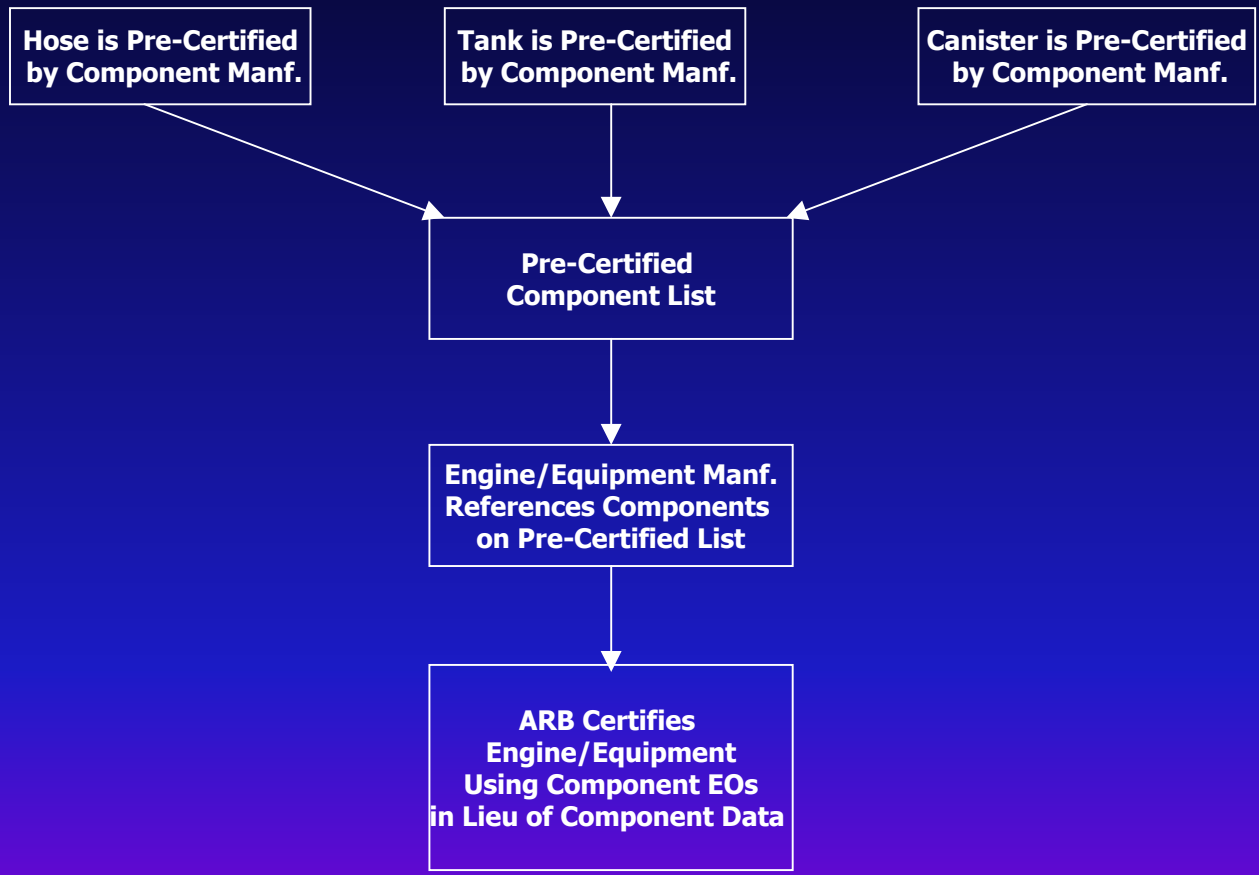
Component Certification

- What is component certification?
  - Component certification is pre-certification of fuel hoses, fuel tanks, and carbon canisters by ARB

Component Certification

- How is component certification useful?
  - Allows manufacturers to reference a pre-certified component Executive Order (EO) in a certification application when certifying by design
  - Multiple OEMs can rely on same component EO
  - Expedites certification process by eliminating the need to review component compliance data

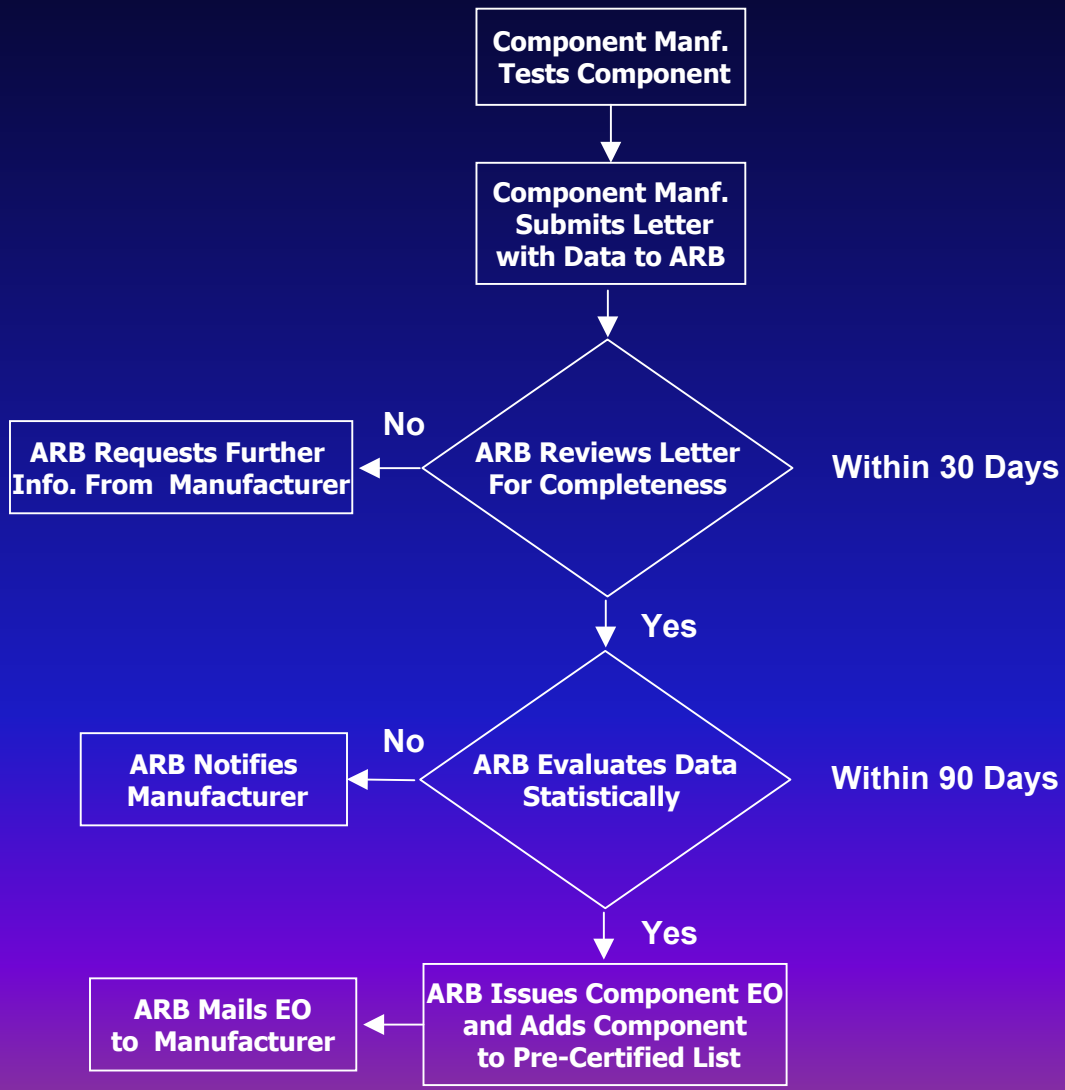
Component Certification
(How it works)



Component Certification

- Who is expected to apply for a component EO
  - Fuel hose manufacturers like Avon Automotive, Mark IV, and Mold-Ex, Inc.
  - Fuel tank manufacturers like Kelch Corp., Honeywell Plastics, and Mergon Corp.
  - Carbon canister manufacturers like Eaton Corp., Delphi Automotive, and Sentec E&E

Component Certification Process Flowchart



Component Certification Process

- Manufacturer tests a minimum of 5 samples of component using applicable test procedure
  - Fuel hose - SAE J1737 (allowable test fuels and test temperatures specified in 13 CCR 2754)
  - Fuel tank - TP-901
  - Carbon canister - TP-902

Component Certification Process

- Manufacturer submits letter with test data requesting a component EO to:

Monitoring and Laboratory Division
Air Resources Board
P.O. Box 2815
Sacramento, CA 95812
Attn: Division Chief

Component Certification Process

- Letter must also include:
  - Reference to the test procedure used to generate the data
  - General description of material composition
  - Drawing of component
  - Installation and maintenance instructions (if applicable)
  - Limits for proper functioning (max load/purge rate for canister etc.)
  - Sample of component or coupon for tanks

Component Certification Process

- Within 30 days
  - Letter deemed complete:
- Within 90 days
  - Data reviewed statistically
  - 95% of extrapolated population must be below applicable standard
  - Component EO with usage limits issued
  - Component added to pre-certified list and posted on ARB's SORE Web site

Component Certification Process
(Fuel Tank Case Study)

Example: A manufacturer seeks a component EO for fluorinated HDPE fuel tanks ranging from 0.25 to 5 gallons

Component Certification Process
(Fuel Tank Case Study Continued)

To obtain a component EO a manufacturer would:

- Generate permeation data for the smallest and largest fuel tanks within the production range
- Test five 0.25 gallon and five 5 gallon tanks following TP-901

Component Certification Process
(Fuel Tank Case Study Continued)

- Submit a letter to ARB requesting a component EO which includes:
  - test data generated following TP-901
  - general material description of the tank (fluorinated HDPE) with CAD drawings of the two tanks
  - an untested sample coupon
  - location and mounting instructions
  - any conditions which might affect the tank's integrity (maximum skin temperature etc.)

Component Certification Process
(Fuel Tank Case Study)

After receiving the request, ARB processes the certification application by:

- Logging the date of receipt
- Assigning a new component EO number
- Reviewing the application for completeness

Component Certification Process
(Fuel Tank Case Study)

- Statistically analyzing the data to ensure that:
  - all data points are below the design criteria of 2.5 grams/meter^2/day
  - ensuring that 95% of extrapolated populations for the 0.25 and 5 gallon tanks are below 2.5 grams/meter^2/day
- Drafting a component EO for the tanks
- Mailing the component EO to the manufacturer

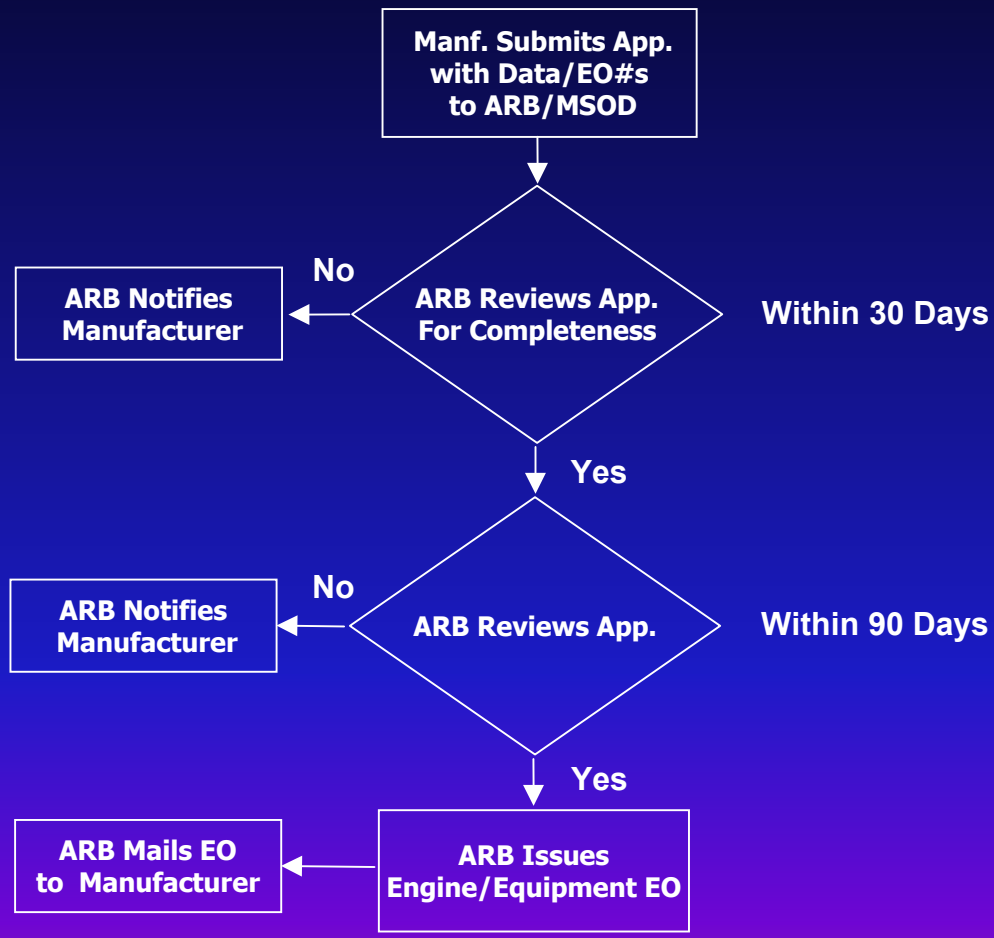
Design-Based Certification > 80cc

- What is design-based certification?
  - Engine or equipment manufacturers use fuel hoses, fuel tanks, and carbon canisters in evaporative emission control systems that meet specific design requirements

Design-Based Certification

- How is design-based certification useful?
  - Allows manufacturers to show compliance without testing the complete evaporative system in a Sealed Housing for Evaporative Determination Enclosure (SHED)

Design-Based Certification Process Flowchart



Design-Based Certification Process

- Manufacturer submits application to:

Mobile Source Operations Division
Off-Road Certification/Audit Section
Air Resources Board
9480 Telstar Avenue, Suite 4
El Monte, CA 91731-2988
Attn: Division Chief

Design-Based Certification Process > 80cc

- Application must include:
  - Component EO numbers in lieu of component test data or, tank and hose permeation data, canister working capacity data
  - Running loss determination
  - Engineering description of evaporative control system
  - Sample engine or equipment label
  - Warranty and Other Applicable Requirements

Design-Based Certification Process

- MSOD reviews application
- MSOD issues Executive Order of Certification

Design-Based System Certification
(Generator Case Study)

- Example: A manufacturer intends to sell three models of generators in California.
- All models use an evaporative system based on the following pre-certified components:
  - Fluoroelastomer multi-layered hoses
  - HDPE tanks with Selar barriers
  - Actively purged carbon canisters

Component Description	EO Number from Pre-certified List
Fluoroelastomer Multi-Layered Hose	GH-05-001
HDPE Tank with Selar Barrier	GT-07-019
Carbon Canister	GC-07-011

Design-Based System Certification

(Generator Case Study Continued)

The generators have the following characteristics:

Generator Model	Engine Disp.	Fuel Tank Volume Liters	Fuel Tank Internal Surf. Area (m^2)	Fuel Line Length (mm)	Fuel Line Inside Dia. (mm)
G8500	260 cc	18.9	0.43	610	7.9
G7500	230 cc	15.1	0.38	492	7.9
G5500	170 cc	11.4	0.30	305	6.4

Design-Based System Certification
(Generator Case Study Continued)

- Prior to submitting a certification application a manufacturer should:
  - Reference component EOs or perform component testing
  - Submit a Letter of Intent
- Prior to submitting a certification application a manufacturer may:
  - Submit a pre-certification package for approval of label and warranty statement

Design-Based System Certification

(Generator Case Study Continued)

- Manufacturer fills out certification application
- Manufacturer submits certification application to:

  Mobile Source Operations Division
  Off-Road Certification/Audit Section
  Air Resources Board
  9480 Telstar Avenue, Suite 4
  El Monte, California 91731-2988
  Attn: Division Chief

Design-Based System Certification

(Generator Case Study Continued)

- Please refer to the sample design-based application handout

Design-Based System Certification
(Generator Case Study Continued)

- ARB processes the application by:
  - Logging the date of receipt
  - Entering certification data into database
  - Reviewing the application
  - Drafting an Evaporative System EO
  - Reviewing and approving the Evaporative System EO
  - Mailing the Evaporative System EO to the manufacturer

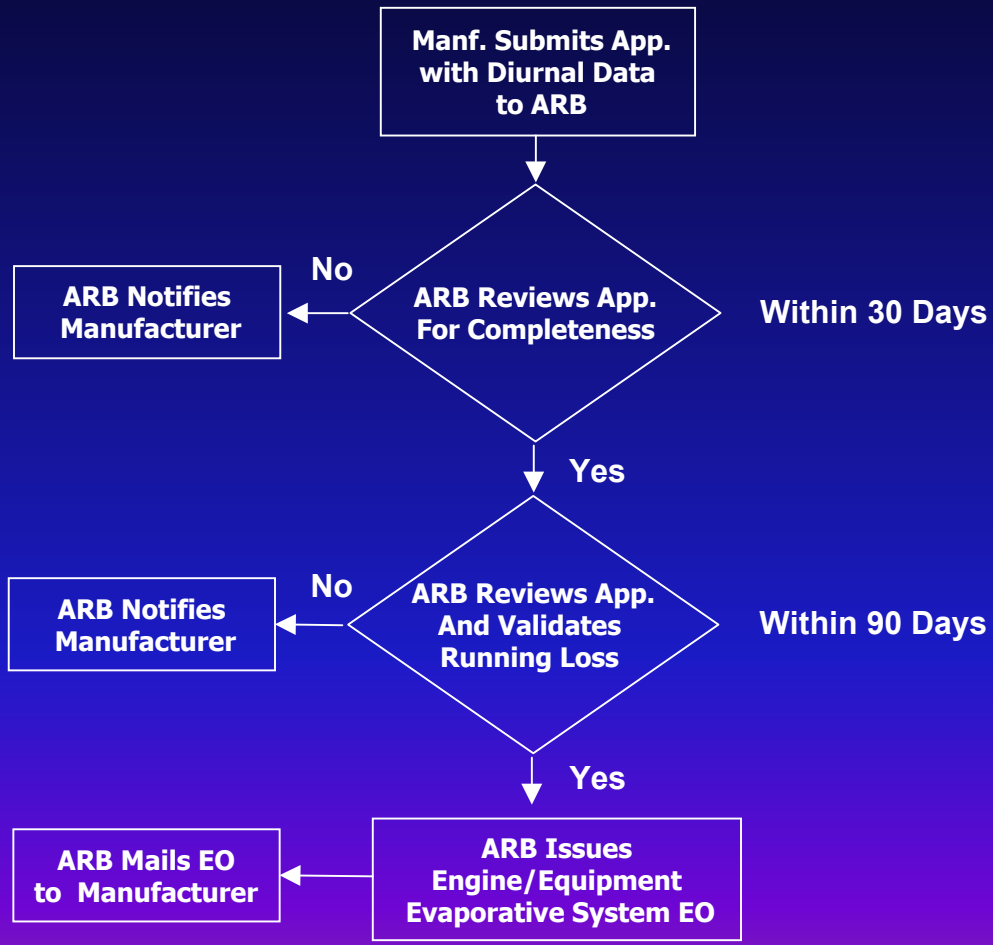
Performance-Based Certification

- What is performance-based certification?
  - Compliance with the evaporative requirements are demonstrated by diurnal testing of engines or equipment with complete evaporative emission systems in a SHED

Performance-Based Certification

- How is performance-based certification useful?
  - "Gold Standard" for demonstrating compliance
  - Manufacturers can take advantage of averaging and banking provisions within the regulations to maximize product offerings

Performance-Based Certification Process Flowchart



Performance-Based Certification Process

- Manufacturer submits application to:

Mobile Source Operations Division
Off-Road Certification/Audit Section
Air Resources Board
9480 Telstar Avenue, Suite 4
El Monte, CA 91731-2988
Attn: Division Chief

Performance-Based Certification Process

- Application must include:
  - Cover Letter/Statement of Compliance
  - Fuel tank permeation data (≤ 80 cc engines)
  - Diurnal emissions data (>80 cc engines)
  - Running loss determination (> 80 cc engines)
  - Engineering description of evaporative control system
  - Sample engine or equipment label
  - Emission warranty

Performance-Based Certification Process

- MSOD reviews application
- MLD validates running loss control
- MSOD issues Executive Order of Certification

Performance-Based System Certification

(Walk-Behind Mower Engine Case Study ~~Continued~~)

- Example is for a walk-behind mower engine that is certified by the engine manufacturer.
- The engine uses an evaporative system based on the following components:
  - Fluoroelastomer multi-layered hose
  - Fluorinated HDPE tank
  - Actively purged carbon canister

Performance-Based System Certification

(Walk-Behind Mower Engine Case Study Continued)

The walk-behind mower engine has the following characteristics:

Engine Model	Engine Disp.	Fuel Tank Volume Liters	Fuel Tank Internal Surf. Area (m^2)	Fuel Line Length (mm)	Fuel Line Inside Dia. (mm)
MV600	185 cc	1.42	0.08	305	6.4

Performance-Based System Certification
(Walk-Behind Mower Engine Case Study Continued)

- Prior to submitting a certification application a manufacturer should:
  - Perform a diurnal test of the engine following TP-902 (result is 0.9 grams HC/day)
  - Submit a Letter of Intent
- Prior to submitting a certification application a manufacturer may:
  - Submit a pre-certification package for approval of label and emission warranty statement

Performance-Based System Certification

(Walk-Behind Mower Engine Case Study Continued)

- Manufacturer fills out certification application
- Manufacturer submits certification application to MSOD

Performance-Based System Certification

(Walk-Behind Mower Engine Case Study Continued)

- Please refer to the performance-based sample application handout

Performance-Based System Certification
(Walk-Behind Mower Engine Case Study Continued)

- After receiving the application, ARB processes the application by:
  - Logging the date of receipt
  - Entering certification data into database

Performance-Based System Certification

(Walk-Behind Mower Engine Case Study Continued)

- Reviewing the application and approving running loss control
- Drafting an engine/evaporative system EO
- Reviewing and approving the engine/evaporative system EO
- Mailing the engine EO to the manufacturer

Compliance
(Pre-Certified Components)

- What happens if ARB identifies a pre-certified component as no longer meeting design specifications?
  - Component EO is revoked
  - Manufacturers may continue to sell current model year engines and equipment
  - Manufacturers may not use the component on engines or equipment the next model year

Compliance
(Design-Based Components)

- What happens if ARB identifies through new equipment compliance testing a design-based component that does not meet design specifications?
  - Manufacturer is notified of ARB's finding
  - Manufacturer may challenge ARB's findings
  - ARB may revoke EO and seek appropriate remedies

Compliance
(Performance-Based Systems)

- What happens if ARB identifies through new equipment compliance testing a system that does not meet the diurnal emission design requirements?
  - Manufacturer is notified of ARB's finding
  - Manufacturer may challenge ARB's findings
  - ARB may revoke EO and seek appropriate remedies

Validation Study

- Purpose is to validate emission reduction goals
- ARB and industry will measure emissions from certified systems
- Study to be conducted in 2010 and 2015
- Executive Officer selects equipment to be tested

Validation Study
continued

Year	Number of Data Points (# of Equipment Tested) for Units Certified per the Performance-Based Standards Under Section 2754(a)	Number of Data Points (# of Equipment Tested) for Units Certified per the Design-Based Standards Under Section 2754(b)
2008	9 (3)	45 (15)
2009	3 (1)	15 (5)
2010	3 (1)	15 (5)
2013	9 (3)	45 (15)
2014	3 (1)	15 (5)
2015	3 (1)	15 (5)

Exemptions

- Handheld equipment using structurally integrated nylon tanks
  - Typical equipment eligible are mainly chainsaws and some models of leaf blowers
  - Exemption allowed because of the thermal resistance properties of nylon 6,6
  - Equipment only exempt from tank permeation standard

Exemptions

- Metal tanks and co-extruded multi-layered tanks
  - Engines and equipment using these tanks do not need to supply tank permeation data in a certification application
  - Exemption allowed because these tanks have inherently low permeation emissions

Exemptions
(Continued)

- Equipment using small production volume tanks
  - Applies to all models with identical tanks produced by an engine or equipment manufacturer with total California sales of 400 or fewer units per year

Exemptions
(Continued)

- Exemption allowed because of cost to replace rotationally molded tanks
- Equipment must use a low permeation line and carbon canister
- Exempt from tank permeation standard

Exemptions
(Continued)

- Generators fueled by vehicle or vessel tank
  - Applies to generators fueled by the fuel tank of an on-road vehicle or marine vessel

Exemptions
(Continued)

- Exemption allowed because on-road vehicles already control evaporative emissions
- Equipment must use a low permeation line
- Exempt from the diurnal performance requirements and the fuel tank permeation and carbon canister design requirements

ARB Contacts and Resources

- MSOD Contact for System Certifications

  Section Manager

  Off-Road Certification/Audit Section

  (626) 575-7040

- MLD Contact for Component Certifications

  Section Manager

  Engineering Development and Testing Section

  (916) 322-8963

ARB Contacts and Resources

- ARB is scheduling a SORE certification guidance workshop for late October 2004 at the ARB auditorium in El Monte.

- SORE regulations and test procedures can be viewed on ARB's web page at:

  http://www.arb.ca.gov/regact/sore03/sore03.htm